

Abstract
Sub 1
electrodes are spaced apart from the conductive material of the microelectronic substrate;
and
moving at least one of the microelectronic substrates and the electrodes
relative to the other while applying an electrical current to the at least one electrode.

4. (Withdrawn)

5. (Cancelled)

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2 ~~2~~ (Amended) A method for removing an electrically conductive material
from a microelectronic substrate, comprising:

positioning a first conductive electrode proximate to the microelectronic
substrate;

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positioning a second conductive electrode proximate to the microelectronic
substrate and spaced apart from the first conductive electrode;

removing the conductive material from the microelectronic substrate by
passing a varying current through the first and second electrodes while the first and second
electrodes are spaced apart from the conductive material of the microelectronic substrate;
and

varying an amplitude and/or polarity of the current at a first frequency and
superimposing on the first frequency an amplitude variation having a second frequency less
than the first frequency.

3 ~~3~~ (Amended) A method for removing an electrically conductive material
from a microelectronic substrate having a planform shape, the method comprising:

selecting a first conductive electrode to have a planform shape generally
similar to a first portion of the planform shape of the microelectronic substrate and selecting
a second conductive electrode to have a planform shape generally similar to a second
portion of the planform shape of the microelectronic substrate;

positioning the first conductive electrode proximate to the microelectronic
substrate;

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positioning the second conductive electrode proximate to the microelectronic substrate and spaced apart from the first conductive electrode; and

removing the conductive material from the microelectronic substrate by passing a varying current through the first and second electrodes while the first and second electrodes are spaced apart from the conductive material of the microelectronic substrate.

4 8/ (Amended) A method for removing an electrically conductive material from a microelectronic substrate, comprising:

positioning a first conductive electrode proximate to the microelectronic substrate;

positioning a second conductive electrode proximate to the microelectronic substrate and spaced apart from the first conductive electrode, the first and second electrodes defining a first electrode pair;

removing a first portion of the conductive material from the microelectronic substrate by passing a varying current through the first and second electrodes while the first and second electrodes are spaced apart from the conductive material of the microelectronic substrate;

positioning a second electrode pair proximate to the microelectronic substrate; and

applying a varying current to the second electrode pair to remove a second portion of conductive material from the microelectronic substrate.

5 9/ (Amended) A method for removing an electrically conductive material from a microelectronic substrate, comprising:

positioning a first conductive electrode proximate to the microelectronic substrate;

positioning a second conductive electrode proximate to the microelectronic substrate and spaced apart from the first conductive electrode;

removing the conductive material from the microelectronic substrate by passing a varying current through the first and second electrodes while the first and second electrodes are spaced apart from the conductive material of the microelectronic substrate,

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C1* the varying current including at least one of a single phase and a multi-phase alternating current.

10. (Withdrawn)

11. (Withdrawn)

12. (Withdrawn)

13. (Cancelled)

14. (Cancelled)

15. (Withdrawn)

16. (Cancelled)

17. (Cancelled)

18. (Cancelled)

19. (Withdrawn)

20. (Withdrawn)

21. (Withdrawn)

*Sub
C1* 22. (Amended) A method for removing an electrically conductive material from a microelectronic substrate, comprising:
positioning a first conductive electrode proximate to the microelectronic substrate;

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positioning a second conductive electrode proximate to the microelectronic substrate and spaced apart from the first conductive electrode;

removing the conductive material from the microelectronic substrate by passing a varying current through the first and second electrodes while the first and second electrodes are spaced apart from the conductive material of the microelectronic substrate; and

at least restricting contact between the first electrode and a liquid adjacent to the first conductive material of the microelectronic substrate by disposing a dielectric film between the first electrode and the liquid.

[23. (Cancelled)

7 24. (Amended) A method for removing an electrically conductive material from a microelectronic substrate, comprising:

positioning a first conductive electrode proximate to the microelectronic substrate;

positioning a second conductive electrode proximate to the microelectronic substrate and spaced apart from the first conductive electrode;

removing the conductive material from the microelectronic substrate by passing a varying current through the first and second electrodes without contacting the first and second electrodes directly with the conductive material of the microelectronic substrate; and

varying an amplitude and/or polarity of the current at a first frequency and superimposing on the first frequency an amplitude variation having a second frequency less than the first frequency.

8 25. (Amended) A method for removing an electrically conductive material from a microelectronic substrate, comprising:

positioning a first conductive electrode proximate to the microelectronic substrate;

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positioning a second conductive electrode proximate to the microelectronic substrate and spaced apart from the first conductive electrode, the first and second electrodes defining a first electrode pair; and

removing the conductive material from the microelectronic substrate by passing a varying current through the first and second electrodes without contacting the first and second electrodes directly with the conductive material of the microelectronic substrate;

positioning a second electrode pair proximate to the microelectronic substrate;

and

applying a varying current to the second electrode pair to remove a second portion of conductive material from the microelectronic substrate.

26. (Cancelled)

27. (Withdrawn)

28. (Withdrawn)

29. (Cancelled)

30. (Cancelled)

31. (Cancelled)

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9 32. (Amended) A method for forming a planarizing medium, comprising:
forming a planarizing pad body having a planarizing surface to engage a surface of a microelectronic substrate;

disposing a first electrode at least adjacent to the planarizing pad body and spaced apart from the planarizing surface with the first electrode coupleable to a source of varying current;

disposing a second electrode at least adjacent to the planarizing pad body with the second electrode spaced apart from the first electrode;

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Conclude

disposing a dielectric material between the first and second electrodes; and
disposing a dielectric film between the planarizing surface and the electrodes.

33. (Withdrawn)

34. (Withdrawn)

35. (Withdrawn)

36. (Withdrawn)

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A method for removing an electrically conductive material from a microelectronic substrate, comprising:

positioning a first conductive electrode proximate to a first portion of the microelectronic substrate;

positioning a second conductive electrode proximate to the first portion of microelectronic substrate and spaced apart from the first conductive electrode, the first and second electrodes defining an electrode pair;

removing the conductive material from the first portion of the microelectronic substrate by passing a varying current through the first and second electrodes while the first and second electrodes are spaced apart from the conductive material of the microelectronic substrate;

moving at least one of the microelectronic substrate and the electrode pair relative to the other to align a second portion of the microelectronic substrate with the electrode pair; and

removing the conductive material from the second portion of the microelectronic substrate by applying a varying current to at least one of the first and second electrodes while the first and second electrodes are spaced apart from the conductive material of the microelectronic substrate.

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¹¹ ~~38.~~ ¹⁰ The method of claim ~~37~~, further comprising:

directing a first flow of electrolyte only to the first portion of the microelectronic substrate when the electrode pair is proximate to the first portion; and
directing a second flow of electrolyte only to the second portion of the microelectronic substrate when the electrode pair is proximate to the second portion.

39. (Cancelled)

40. (Cancelled)

41. (Cancelled)

42. (Cancelled)

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¹² ~~43.~~ A method for removing an electrically conductive material from a microelectronic substrate, comprising:

positioning a first conductive electrode at least proximate to a first portion of the microelectronic substrate;

positioning a second conductive electrode at least proximate to the first portion of the microelectronic substrate and spaced apart from the first conductive electrode, the first and second electrodes defining a first electrode pair;

positioning a second electrode pair at least proximate to a second portion of the microelectronic substrate, the second electrode pair including a third electrode and a fourth electrode spaced apart from the third electrode; and

removing the conductive material from the microelectronic substrate by passing a first varying current through the first and second electrodes and passing a second varying current through the third and fourth electrodes.

¹³ ~~44.~~ ¹² The method of claim ~~43~~, further comprising spacing the first and second electrodes apart from the microelectronic substrate while applying the first varying current.

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45. The method of claim 43, further comprising spacing the first electrode pair a first distance from a surface of the microelectronic substrate and spacing the second electrode pair a second distance from the surface of the microelectronic substrate with the first distance greater than the second distance.

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46. The method of claim 43, further comprising:
spacing the first and second electrode pair apart from each other by a first distance;

spacing a third and fourth electrode pair apart from each other by a second distance greater than the first distance, with each of the third and fourth electrode pairs including two spaced apart electrodes;

aligning the third electrode pair with a third portion of the microelectronic substrate and aligning the fourth electrode pair with a fourth portion of the microelectronic substrate; and

removing the conductive material from the third and fourth portions of the microelectronic substrate by passing a third varying current through the third electrode pair and passing a fourth varying current through the fourth electrode pair.

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47. The method of claim 43 wherein the first varying current is approximately identical to the second varying current.

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48. The method of claim 43 wherein an amplitude of the first varying current is greater than an amplitude of the second varying current.

49. (Cancelled)

50. (Cancelled)

51. (Withdrawn)

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18⁵² (Amended) An apparatus for removing conductive material from a microelectronic substrate, comprising:

a support member having at least one engaging surface to support the microelectronic substrate;

a first electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member;

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a second electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member, the second electrode being spaced apart from the first electrode, at least one of the first and second electrodes being coupleable to a source of varying current; and

a dielectric layer at least proximate to the first electrode, the dielectric layer being positioned between the microelectronic substrate and the first electrode when the microelectronic substrate is supported by the support member.

19⁵³ (Amended) An apparatus for removing conductive material from a microelectronic substrate, comprising:

a support member having at least one engaging surface to support the microelectronic substrate;

a first electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member;

a second electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member, the second electrode being spaced apart from the first electrode; and

a current source configured to vary an amplitude of the current at a first frequency, the current source including an amplitude modulator to superimpose on the first frequency an amplitude and/or polarity variation having a second frequency less than the first frequency, wherein at least one of the first and second electrodes is coupleable to the current source.

54. (Withdrawn)

20 55. (Amended) An apparatus for removing conductive material from a microelectronic substrate, comprising:

a support member having at least one engaging surface to support the microelectronic substrate;

a first electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member;

a second electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member, the second electrode being spaced apart from the first electrode, the first and second electrodes defining a first electrode pair, at least one of the first and second electrodes being coupleable to a source of varying current;

a third electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member; and

a fourth electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member, the fourth electrode being spaced apart from the third electrode, at least one of the third and fourth electrodes being coupleable to a source of varying current.

21 56. (Amended) An apparatus for removing conductive material from a microelectronic substrate, comprising:

a support member having at least one engaging surface to support the microelectronic substrate;

a first electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member; and

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a second electrode spaced apart from the support member and from the microelectronic substrate when the microelectronic substrate is supported by the support member, the second electrode being spaced apart from the first electrode; and

a current source that includes a single phase or a multi-phase alternating current supply, wherein at least one of the first and second electrodes is coupleable to the current source.

57. (Withdrawn)

58. (Withdrawn)

59. (Withdrawn)

60. (Withdrawn)

61. (Cancelled)

62. (Cancelled)

63. (Cancelled)

64. (Withdrawn)

65. (Withdrawn)

66. (Cancelled)

67. (Cancelled)

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68. (Amended) An apparatus for removing a conductive material from a microelectronic substrate, comprising:

a carrier having at least one engaging surface to support a microelectronic substrate;

a polishing pad proximate to the carrier and having a polishing surface to engage the microelectronic substrate, at least one of the polishing pad and the carrier being movable relative to the other;

a first electrode proximate to the polishing surface; and

a second electrode proximate to the polishing surface and spaced apart from the first electrode; and

a current source configured to vary an amplitude of the current at a first frequency, further wherein the current source includes an amplitude modulator to superimpose on the first frequency an amplitude and/or polarity variation having a second frequency less than the first frequency, and wherein at least one of the first and second electrodes is coupleable to the current source.

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69. (Amended) An apparatus for removing a conductive material from a microelectronic substrate, comprising:

a carrier having at least one engaging surface to support a microelectronic substrate;

a polishing pad proximate to the carrier and having a polishing surface to engage the microelectronic substrate, at least one of the polishing pad and the carrier being movable relative to the other;

a first electrode proximate to the polishing surface;

a second electrode proximate to the polishing surface and spaced apart from the first electrode, at least one of the first and second electrodes being coupleable to a source of varying electrical current, the first and second electrodes defining a first electrode pair;

a third electrode spaced apart from the carrier and from the microelectronic substrate when the microelectronic substrate is supported by the carrier; and

a fourth electrode spaced apart from the carrier and from the microelectronic substrate when the microelectronic substrate is supported by the carrier, the fourth electrode

Exclude
being spaced apart from the third electrode, at least one of the third and fourth electrodes being coupleable to a source of varying current.

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70. (Withdrawn)

71. (Withdrawn)

72. (Withdrawn)

73. (Withdrawn)

74. (Cancelled)

75. (Cancelled)

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An apparatus for removing an electrically conductive material from a microelectronic substrate, comprising:

a support member having at least one engaging surface to support the microelectronic substrate;

first and second conductive electrodes spaced apart from each other and defining a first electrode pair, the first electrode pair being at least proximate to the microelectronic substrate when the microelectronic substrate is supported by the support member, at least one of the first and second electrodes being coupleable to a source of varying current; and

third and fourth conductive electrodes spaced apart from each other and defining a second electrode pair spaced apart from the first electrode pair, the second electrode pair being at least proximate to the microelectronic substrate when the microelectronic substrate is supported by the support member, at least one of the third and fourth electrodes being coupleable to a source of varying current.